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TESTING AND EVALUATION OF EXISTING TECHNIQUES FOR IDENTIFYING UPTAKES AND MEASURING RETENTION OF URANIUM IN MILL WORKERS

by

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TESTING AND EVALUATION OF EXISTING TECHNIQUES FOR IDENTIFYING UPTAKES AND MEASURING RETENTION OF URANIUM IN MILL WORKERS

Prepared by Monserco Limited, under contract to the Atomic Energy Control Board.

ABSTRACT

Preliminary tests and evaluations of existing bio-analytical techniques for identifying uptakes and measuring retention of uranium in mill workers were made at two uranium mills. Urinalysis tests were found to be more reliable indicators of uranium uptakes than personal air sampling. Static air samples were not found to be good indicators of personal uptakes. In vivo measurements of uranium in lung were successfully carried out in the presence of high and fluctuating background radiation. Interference from external contamination was common during end of shift measurements. A full scale study to evaluate model parameters for the uptake, retention and elimination of uranium should include, in addition to the above techniques, particle size determination of airborne uranium, solubility in simulated lung fluid, uranium analysis in faeces and bone and minute volume measurements for each subject.

RÉSUMÉ

On a fait des essais et des évaluations préliminaires de techniques bio-analytiques existantes pour identifier l'apport et mesurer la rétention d'uranium chez les travailleurs à deux usines de concentration d'uranium. Les analyses d'urines se sont révélées des indicateurs d'apport d'uranium plus fiables que les échantillonnages d'air individuels. Les échantillons statiques d'air ne se sont pas révélés de bons indicateurs d'apports individuels. On a effectué avec succès des mesures in vivo d'uranium dans les poumons en présence d'un fond de rayonnement fluctuant et de haute énergie. L'interférence causée par la contamination extérieure était fréquente lors de la prise des mesures à la fin des périodes de travail. Une étude de grande envergure pour évaluer des paramètres modèles de l'apport, de la rétention et de l'élimination de l'uranium devrait inclure, en plus des techniques déjà mentionnées, la détermination de la dimension des particules d'uranium en suspension dans l'air, leur solubilité dans un fluide pulmonaire simulé, l'analyse de l'uranium dans les fèces et les os, ainsi que des mesures de volume infime chez chaque sujet.

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1.0 INTRODUCTION

This report describes the testing and evaluation of existing techniques for identifying uptakes and measuring retention of uranium in mill workers. As part of the research and development efforts of the Atomic Energy Control Board (AECB), this study addresses the protection of workers from uranium uptakes which can exert both chemical toxic effects on the kidney and radiological exposures to various body organs such as lung, bones and kidneys. The objective of this study was to evaluate the feasibility of applying to uranium mill workers the existing bio-analytical techniques (first established for uranium fuel fabrication workers) for identifying uptakes and measuring retention of uranium in occupational environments. The measurement techniques tested and evaluated include bioassay determinations of uranium in urine and lung, measurements of uranium in air and measurements of Th234/U238 equilibrium.

On May 13, 1982 Monserco staff began preparing equipment, gathering supplies and organizing the program to be carried out at two uranium mills (operated by different companies) having different end products (a) ammonium diuranate and (b) a combination of ammonium and magnesium diuranate. At meetings arranged by the AECB on June 22, 1982 Monserco staff described the study to management and safety personnel of both companies and executives of the union representing the subjects. Six volunteers were selected from each of the two companies and the experimental program was explained to them in detail.

The testing program was begun on September 18, 1982 and continued uninterrupted through to October 22, 1982. Airborne uranium concentrations were measured by using

static air monitors and personal air monitors given to each subject. Urine specimens were collected from each subject and uranium concentrations were measured. Uranium lung burdens were measured using gamma spectroscopy. Some urine samples were split and aliquots sent for inter-laboratory comparison to the Radiation Protection Bureau (RPB) of Health and Welfare Canada. Calibration of the lung counting system had previously been carried out in May 1982 using the Rando phantom from the RPB.

The study was intended to test measurement techniques and not as an assessment of prevailing conditions in uranium mills. No attempt was made to select subjects as representative of mill conditions and therefore these results should not be used to draw conclusions about general conditions at either of the uranium mills involved. Neither should the mills be compared one to the other on the basis of the results reported below.

2.0 EXPERIMENTAL PROGRAM

The experimental program included a total of 12 subjects, 6 from each of the two facilities. The subjects were all above ground workers in the mill environment and were exposed to one or both of magnesium and ammonium diuranate. There was continuous coverage, while at work, of all 12 subjects throughout the five weeks of the study. Workers who used respirators or other protective breathing devices were excluded from the study so that there would be the highest probability of direct relationships between air, urine and lung measurements.

2.1 Uranium in Urine Determinations

The urinary system is one of the two routes for elimination of uranium after inhalation and was monitored closely in this study.

Urine samples were collected from all of the subjects on a regular basis and uranium in urine determinations were made by the delayed neutron counting technique. From some specimens duplicate samples were taken and sent to the Radiation Protection Bureau for analysis. In addition, some duplicates were analysed by Monserco.

Two sampling regimes were used during the five week collection period. One sampling regime covered a continuous 72 hour period during which each and every voiding was collected in a separate specimen bottle. The subjects recorded the date and time of voiding. Each specimen was analysed separately for uranium and the volume was measured. Throughout the remainder of the five week study period each subject was requested to give a urine sample immediately before starting a work shift and a separate specimen immediately after showering and changing clothes at the end of the work shift. For both specimens, the subjects were requested to empty the bladder completely and record the time of voiding and the time of the previous voiding. Each specimen was analysed separately for uranium and the specimen volume was measured.

2.2 Personal Air Sampling

Throughout the five weeks of the study each of the 12 subjects was issued a personal air sampler with a new filter for each work shift. The impactor filter heads were of CANMET design and at a flow rate of 1.9 litres per minute passed only respirable size particles with a mass distribution similar to a horizontal elutriator. The air pumps used were SIMQUADS manufactured by Cassella and controlled flow rate pumps from Dupont. Type A-E glass fibre filters were used to collect the respirable

size particles rather than silver membrane filters because of the lower background count rate for delayed neutron counting. The operating time of the SIMQUAD pumps was determined by means of the counter. Due to battery limitations the pump operating time was not necessarily equal to the length of the shift. Each of the glass fibre filters was individually analysed for uranium loading by the delayed neutron counting method.

2.3 Static Air Sampling

Throughout the 5 week study two static samplers were located at work sites at each of the two mills. Separate filters were installed for each work shift and the uranium on each filter was later determined by delayed neutron counting.

An automatic timer controlled the operation of the air pump and pumping rates were held constant at either 0.84 or 0.60 m^3/h through the use of critical orifices. The open face filter head was supported 1.7 metres above the floor and membrane filters with pore size 0.8 µm were held with the plane of the face perpendicular to the floor.

2.4 Th234/U238 Equilibrium Measurements

Samples of uranium product were collected from each of the mills and the Th234/U238 equilibrium was determined by gamma spectroscopy using phoswich detectors. The equilibrium condition of inhaled uranium has significance with respect to the lung counting technique described below because Th234 the first daughter of U238 is the radioisotope measured.

After chemical separation of thorium from the uranium product in the milling process the Th234/U238 equilibrium will also be disrupted. The extent of disequilibrium

in a given sample was determined by making a comparative measurement of the ratio of the 63-93 keV region (Th234) to the 185 keV region (U235) in the unknown sample. A similar measurement was made of a sample in which it was known that equilibrium had been established.

About 100 mg of each sample was spread into a thin layer between sheets of plastic which were glued together. Alternately, the 12.5 cm square samples were sandwiched between two 12.5 cm diameter phoswich detectors and the gamma spectra accumulated.

2.5 Uranium Solubility in Simulated Lung Fluid

Samples of the materials that had been collected for the analysis of Th234/U238 equilibrium were to be used for determination of solubility in simulated lung fluid.

2.6 Thorax Burden Measurements

Throughout the last four weeks of the study uranium lung burden determinations were made on each of the 12 subjects. Measurement times for each subject were split between the beginning and the end of the work shift. The Monserco Mobile Lung Counter was positioned close to both mills for the convenience of the subjects and to minimize lost work time. The location of the counter was also based in part on the results of a survey of background radiation in the vicinity of the two uranium mills.

The measurement procedure, which has been documented by Monserco (Ref. 4) required that the subject change into a set of clothes provided by Monserco and then lie supine

in a shielded bed. Two phoswich detectors were positioned 8 cm above the center of the lungs and a 33 minute measurement was made. Either before or after the measurement of the subject a background measurement was made using a water phantom. At least once each day gamma energy and efficiency measurements were checked.

3.0 RESULTS

3.1 Uranium in Urine Measurements

The results of the spot uranium in urine measurements made at the beginning and end of each work shift are given separately for each worker in Tables 1 to 23. The shift hours worked by the subject on each date are given in column 2 and the data pertinent to the urine sample given at the beginning of the shift are recorded in columns 6 to 9 on the same line. The data pertaining to the urine sample given at the end of the shift are recorded immediately below. The time of voiding and the time of the last previous voiding were recorded. The volume of urine in the specimen was measured and recorded before a 40 mL aliquot was taken for delayed neutron counting. The minimum detectable concentration of uranium was 2ug U/L of urine.

The results of the 72 hour continuous urine sampling program are given for each subject in Appendix 1. The first two digit entry under the Company Code column is the subject's number followed by the day and the month. The time that the sample was given and the volume are also recorded.

The results of the interlaboratory comparison measurements between Monserco and RPB are summarized in Table 28. In general there is good agreement between the two sets of analysis with a correlation coefficient of 0.87.

3.2 Personal Air Sampling

The results of the personal air sampling measurements which covered all work shifts throughout the study period are given separately for each subject in Tables 1 to 23. A new glass fibre filter was used for each subject for each shift. The operating time of the SIMQUAD pumps is recorded in column 4 in hours. Column 4 is left blank for the Dupont pumps. Each filter was analysed separately for uranium content by delayed neutron counting and the result is entered in column 5. Unused glass fibre filters were tested and found to contain 0.02 ug uranium on average whereas, silver membrane filters were found to contain uranium (or equivalent interference) ranging as high as 10 ug.

Reference Man (Ref. 2) doing light work inhales 20 L of air per minute. Since the personal air samplers operated at 1.9 L/min., the amount of uranium inhaled by the subject during the operating time of the pump is about 10 times the amount of uranium on the filter.

3.3 Static Air Sampling

Static air samplers in Facility A were located in the drum filter areas (air sampling pumps 111 and 112). The results of the measurements are recorded in Tables 29 and 30. The air concentration reported in the right hand column includes airborne particles of all sizes. All six subjects from Facility A were on the same shift so the timer controls on the static air pumps were set to operate during these shifts.

3.4 Th234/U238 Equilibrium Measurements

Various samples of process material were collected during the 5 week study period and analysed for Th234/U238 equilibrium ratio. Such potential airborne material as precipitation tank overflow and drying and packing product were gathered. The results of some of these analyses showed a surprisingly high fraction of Th234 present at the time that the samples were taken. All five samples of 'yellowcake' in which there were very high concentrations of uranium had Th234 at 60 to 72% of equilibrium with U238. All of the drum sludge materials that were sampled were so high in Th232 and its daughter radiations that Th234 and U235 were undetectable.

3.5 Uranium Solubility Measurements

The results of uranium compound solubility in simulated lung fluid were not available at the time of printing of this report.

3.6 Thorax Burden Measurements

Using a scaling dosimeter, a gamma survey had been made of possible Mobile Lung Counter sites near the uranium mills. The results of that survey are recorded in Table 25 and indicated background radiation levels about three times the level measured at Monserco's Lab in Mississauga. Since all usable locations had equivalent background levels, the counter was located at a camp site near the mills for the convenience of the subjects.

The results of initial background and control person measurements indicated that the scattered radiation from a water phantom inside the shielded bed was only twice as high as it had been at Mississauga and the total

radiation from a control person was only 50% higher than at Mississauga. This is a consequence of the fact that when a control person is measured at Mississauga 50% of the observed radiation from the subject originates within the subject (K40, Cs137 etc.) and the other 50% is scattered radiation from outside the shield.

Throughout the five week study period there were significant temporal fluctuations in the background measured within the shielded bed. This background is partially caused by the decay of radon daughters and the fluctuations appeared correlated with changes in atmospheric conditions around the shield. The analytical background subtraction model, described in procedure M21 Rev. 1, adequately compensated for the variations in background. However, the increased average background level resulted in an increase in the minimum detectable amount (MDA) of uranium in the lung from 4 mg to 6 mg.

Three to five lung burden measurements were made on each of the subjects throughout the last four weeks of the study period and a single measurement was made on each of 17 control people. To determine the background subtraction when calculating lung burdens the following model was used.

$$B1 = (C1 + C2 \times C) \times B2$$

where

B1 = counts in the 38 to 110 keV region of the spectrum.

C = chest circumference in metres

B2 = counts in the 110 to 165 keV region of the spectrum

C1, C2 constants to be evaluated.

The values for C1 and C2 were calculated to be 1.48 and 0.59 from a least squares fit of the control group and subject data to the above function. The lung burdens were then evaluated by calculating a value for B1 based on the observed value of B2, subtracting the calculated value of B1 from the observed value of B1 and multiplying by the normalizing and calibration factors determined using the RPB Rando phantom: 86.9 counts per 2000 seconds per mg uranium. The results are recorded in column 10 of Tables 1 to 23 in the row corresponding to the date on which the measurement was made. The notation 'B' or 'E' was used to denote measurements made Before the subject started his work shift and at the End of the work shift respectively.

4.0 DISCUSSION

For each subject, personal air sampling data was used to calculate the amount of uranium inhaled during each work shift. In order to make this calculation it was assumed that the airborne uranium concentration was the same for the full 8 or 12 hour shift as was measured during the operating time of the pump. Also it was assumed that the breathing rate of the subject was 20 L/min as recommended by ICRP for Reference Man doing light work (2). The calculated values for the uranium inhaled during each shift throughout the study period were averaged, and the standard deviation calculated. The results are shown in Table 34. Also shown are the averages and standard deviations of the end of shift uranium in urine concentrations. There is an apparent correlation between these two variables which merits further investigation because, if verified, it indicates that working limits could be established on the basis of urinalysis alone. On a subject by subject basis the

results of individual personal air samples and end of shift urine samples that exceeded one standard deviation above the respective average values are identified, recorded in Table 35, and classified in Figure 1. Those entries which appear in the upper right box indicate agreement. Entries in the upper left and lower right segments indicate either a false positive or a false negative result for one procedure. On two occasions air sampling was identified as giving a false positive result because the sampler operated only a small fraction of the total shift time and therefore, did not collect a representative sample of the shift average air concentration. Out of a total of 22 'events' only 5 resulted in agreement. On 9 occasions there was either false positive urinalysis or false negative personal air readings. For the remaining 6 occasions there were either false positive indications for air sampling or false negative urinalysis. Again, if confirmed, these data would indicate that if only one monitoring technique were to be used it should be urinalysis since there would be fewer false negative events and consequently fewer undetected uptakes. This result is not surprising since personal air monitoring has several limitations by comparison with urinalysis. Air monitors operate at flow rates which may not represent accurately individual inhalation rates since respiration depends on many factors such as the difficulty of the task. In addition, personal samplers cannot reflect precisely the concentration of inhaled air although attempts are made to position the sampling head in the breathing zone. Finally, in the work environment of uranium mills it would be impossible for existing personal air samplers to provide complete coverage. With appropriate sampling procedures, if one urine sample is missed or rendered useless, another can be taken with little information loss. If a personal air sampler fails to operate and such

a condition is undetected there is no means of regaining the lost information. In future studies the accuracy of the calculation of inhaled uranium could be significantly improved by making measurements of minute volumes for each subject doing light work. This would provide subject specific data to be used in place of the default value of 20 L/min. recommended by ICRP.

The limitations imposed by the numbers of subjects studied mean that it is unlikely that correlations between static air sampling data and individual subject uptakes would be significant. The present data indicate that there is little agreement between these measurements. There was one occasion (Oct. 20, subject 22) when both the personal air sampler and urinalysis indicated an uptake and the static sampler operating during that shift also indicated a high level. However, when the calculated amounts of uranium inhaled during the excursion are compared, the static sampler measurements give no indication of the true size of the uptake by the worker. The static samplers may be a suitable means of assessing the general air environment in specific areas of the mills but appear not to be effective for monitoring and protecting workers. It may be that the use of size selection heads on the static samplers will give more useful information about respirable uranium. A conclusive study must be organized with a larger number of subjects included for each task category so that these conclusions can be verified. Obviously from the workers viewpoint, static air sampling is the most convenient monitoring procedure.

The lung burden determinations have been calculated assuming that the equilibrium rate of Th234/U238 was unity. Since measurements showed that it was in the range 0.6 to 0.7, current lung burden readings are consistent with personal air sampling measurements that indicate maximum intakes

of 1.2 mg during the 5 week study (Subject 22, Oct 22). If there had been significant intakes in the past which resulted in chronic lung burdens, they would have been detected by the technique used since the equilibrium rates would have reached unity. Future measurements of equilibrium ratios will be determined using a HpGe detector to avoid interferences associated with Th232.

Based on personal air sampling, urinalysis and lung counting results, it appears that with the exception of subject 24 all the indicated lung burdens above 6 mg have been caused by some form of contamination. The 18keV x-ray from uranium was not prominent in the recorded spectra. This indicates that perhaps hair, nose or hand contamination rather than chest surface contamination may be present. If it is necessary to make measurements at the end of shifts different shielding configurations may be advisable to shield the hands or head.

Urinalysis results in this study suggest that the inhaled uranium is very soluble since it is cleared from the body quickly. If this is verified by uranium compound solubility in simulated lung fluid measurements, it may be necessary in future to measure uranium retention in bone to successfully determine mass balance relationships.

5.0 CONCLUSIONS AND RECOMMENDATIONS

It is necessary to identify and control airborne uranium uptakes by workers in order to prevent uranium from exerting both chemical toxic effects on the kidney and radiological exposures to various body organs such as lung, bones and kidneys.

Tentative conclusions concerning the usefulness of the monitoring techniques examined in this study were drawn by comparing the results of different procedures for the same subject. The conclusions reached must be tentative since the number of subjects examined was small. The primary goal of this study was to establish that these monitoring techniques could be applied to mill workers. The results indicate a large survey is a practical, worthwhile proposition which is likely to produce valuable information with respect to the optimum techniques required for personnel monitoring in uranium mills. The results of a complete full scale survey can be used to determine the appropriate monitoring procedures for personnel involved in specific job categories and to determine coefficients in applicable intake, retention and elimination models.

The data collected during this feasibility study indicate that personal air sampling, lung counting and urinalysis each, at least qualitatively, reflect uptakes, retention and elimination respectively of uranium in mill workers. Without detailed quantitative analysis in a larger group of subjects, it is not possible to determine whether any monitoring technique is sufficient on its own to describe uranium

metabolism. In order to make quantitative analyses of the parameters describing the uptake of uranium in mill workers it will be necessary to take personal air samples of the breathing zone air around the subject. The determination of retention should include uranium in bone determinations as well as uranium in lung measurements. The minimum detectable amount for the latter will have to be reduced from current levels (6 mg) by decreasing background, relocating the mobile lab and extending counting times. Uranium elimination should be monitored from measurements of faeces and urine uranium content in order to determine mass balances. If the uptake, retention and elimination parameters can be established for the uranium compounds to which mill workers in various job categories are exposed, routine monitoring techniques will not need to include all of these procedures.

Our tentative analysis indicates that urinalysis appears to be the most reliable method of identifying uptakes of uranium. Urinalysis has the advantages of minimal interference with worker performance and a greater reliability and hence cost effectiveness. When the parameters relating retention and elimination are determined it will be possible to recommend testing frequencies, action levels and MDA levels. Depending on the outcome of the large scale study to follow and the results of solubility studies, it may be necessary to monitor routinely the lungs or bones of workers. There may be sufficient uptake of W and Y class uranium compounds that long term buildup of these materials may be of significance. Similarly the chronic intake of D class material may result in a long term buildup of uranium in bone.

A large scale follow-up study is required to address the points raised above. Quantitative determinations of the uptake, retention and elimination parameters for the various uranium compounds found in uranium mills is required. Optimum methods and monitoring schedules can then be established for all job types including maintenance, outside contractors and operations personnel. The proposed study must include statistically representative numbers of workers within each job and work history category for both males and females. The monitoring methods should include those used in this study together with minute volumes measurements, particle size determinations, fecal analysis and uranium in bone determinations. The fact that Monserco has successfully completed this pilot study indicates that the large scale study can be undertaken with confidence and that reliable conclusions can be reached upon which monitoring requirements for all workers in uranium mills can be established.

6.0 REFERENCES

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3. Determination of Natural Uranium Concentration in Urine, Procedure M12 Rev. 0 July 1979, Monserco Limited.

4. Determination of Natural Uranium Thorax Burdens Using Phoswich Detectors in a Mobile Shadow Shield, Procedure M21 Rev. 1, Sept. 1982. Monserco Limited.

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The twelve subjects who participated in the project were most cooperative and willing to carry out the extra tasks that were requested of them. The mine/milling companies gave support by making time available for the testing of their employees, providing some of the air sampling equipment and offering the assistance of their support staff. The assistance of the CANMET Laboratory in Elliot Lake which provided some personal air sampling pumps, and related equipment is also appreciated.

The Radiation Protection Bureau of Health and Welfare Canada which analysed some of the urine samples as part of an interlaboratory comparison program was most helpful.

FIGURE 1

URANIUM UPTAKES INDICATED BY URINALYSIS AND PERSONAL AIR SAMPLING

PERSONAL AIR SAMPLING	NEG	POS
POS	12 SEPT 28 13 SEPT 24 13 OCT 13 21 SEPT 27 24 SEPT 20 25 OCT 4	11 SEPT 24 12 SEPT 24 15 OCT 16 21 SEPT 28 22 OCT 20
NEG	11 SEPT 29 11 OCT 21 12 OCT 12 12 OCT 21 13 OCT 7	15 OCT 7 24 OCT 18 25 OCT 8 25 OCT 12

END OF SHIFT URINALYSIS

TABLE 1

SUBJECT: 11

DATE	SHIFT	SAMPLE NO.	PUMP TIME	µg U on FILTER	TIME OF VOIDING	LAST VOIDING	VOL CM^3	µg U Per L	Lung Burden mg U *
Sept 18	2000-0800	18-11	10.4	0.65	8:45 PM	-	202	3	
					(19) 7:43 AM	3:50 AM	164	6	
Sept 19	2000-0800	19-11	10.6	0.49	7:20 PM	3:05 PM	154	2	
					(20) 7:47 AM	10:05 PM	195	3	
Sept 20	2000-0800	20-11	8.7	0.76	7:50 PM	2:20 PM	167	2	
					(21) 7:50 AM	5:15 AM	123	4	
					(22) 5:30 AM	11:30 PM	605	<2	
Sept 23	800-2000	23-11	9.0	0.45	6:30 AM	11:30 PM	367	<2	< 6 mg B+
					7:04 PM		184	6	
Sept 24	800-2000	24-11	5.5	0.68	6:19 AM	8:19 PM	410	<2	
					6:30 AM	11:30 PM	461	3	
					6:45 PM	4:00 PM	136	8	
Sept 28	2000-800	28-11	10.8	0.66	6:30 PM	4:00 PM	173	<2	
					(29) 6:45 AM	3:30 AM	111	2	
Sept 29	2000-800	29-11	10.1	0.84	6:45 PM	4:30 PM	163	<2	
					(30) 6:00 AM	2:30 AM	81	8	< 6 mg E++
Oct 2	800-2000	2-11	-	0.81	6:30 AM	11:30 PM	335	<2	
					6:30 PM	11:20 AM	220	3	
Oct 3	800-2000	3.11	-	0.49	6:30 AM	11:00 PM	539	<2	
					6:35 PM	3:20 PM	221	6	
Oct 4	800-2000	4-11	9.3	0.58	6:30 AM	11:20 PM	486	3	
					6:30 PM	3:20 PM	200	5	< 6 mg B

+ B= beginning of shift
++ E= end of shift
*= assuming U238/Th234 Equilibrium ratio is unity

TABLE 2

SUBJECT: 11

DATE	SHIFT	SAMPLE NO.	PUMP TIME	µg U on FILTER	TIME OF VOIDING	LAST VOIDING	VOL CM^3	µg U Per L	Lung Burden mg U
Oct 7	2000-800	7-11	8.7	-	6:00 PM	3:10 PM	187	<2	
					(8) 6:35 AM	3:00 AM	133	3	
Oct 8	2000-800	8-11	-	0.38	6:45 PM	2:40 PM	205	<2	
					(9) 6:40 AM	4:20 AM	100	3	
Oct 12	800-2000	12-11	9.1	0.78	6:30 AM	11:20 PM	424	<2	< 6 mg E
					6:00 PM	4:00 PM	34	3	
Oct 13	800-2000	13-11	10.4	0.41	6:30 AM	11:30 PM	400	<2	
					6:40 PM	3:35 PM	131	2	
Oct 16	2000-800	ABSENT							
Oct 17	2000-800	17-11	8.2	0.37	6:30 PM	3:00 PM	244	<2	
					(18) 6:40 AM	4:00 AM	92	2	
Oct 18	2000-800	18-11	2.7	0.30	6:20 PM	2:40 PM	222	<2	
					(19) 6:35 AM	3:00 AM	247	3	
Oct 21	800-2000	21-11	6.6	0.53	6:30 AM	11:10 PM	324	56	
					6:30 PM	3:00 PM	229	11	
									< 6 mg E

TABLE 3

SUBJECT: 12

DATE	SHIFT	SAMPLE NO.	PUMP TIME	µg U on FILTER	TIME OF VOIDING	LAST VOIDING	VOL CM^3	µg U Per L	Lung Burden mg U
Sept 18	2000-800	18-12	10.3	0.90				2	
								<2	
Sept 19	2000-800	19-12	10.7	1.05	7:25 PM	1:50 PM	210	<2	
					(20) 6:30 AM	1:30 AM	239	4	
Sept 20	2000-800	20-12	10.7	0.76	6:30 PM	5:00 PM	172	<2	
					(21)				
Sept 23	800-2000	23-12	10.9	0.52	6:30 AM	11:30 PM	447	<2	
					7:30 PM	5:00 PM	118	3	
Sept 24	800-2000	24-12	5.3	2.20	6:35 AM	10:30 PM	226	2	<6 mg B
					7:55 PM	3:00 PM	344	7	
Sept 28	2000-800	28-12	10.3	2.70	7:40 PM	4:40 PM	197	<2	
					(29) 8:00 AM	4:10 AM	210	<2	
Sept 29	2000-800	29-12	11.4	0.23	7:15 PM	3:20 PM	224	3	
Oct 2	800-2000	2-12	10.2	2.71	6:05 AM	9:15 PM	400	<2	<6 mg E
					6:35 PM	12:45 PM	525	4	
Oct 3	800-2000	3-12	9.8	0.83	6:10 AM	11:25 PM	231	4	
					7:40 PM	1:25 PM	320	2	
Oct 4	800-2000	4-12	10.5	0.56	6:20 AM	12:15 PM	279	<2	
					7:20 PM	1:25 PM	223	2	
Oct 7	2000-800	7-12	ABSENT						
Oct 8	2000-800	8-12	ABSENT						

TABLE 4

SUBJECT: 12

DATE	SHIFT	SAMPLE NO.	PUMP TIME	µg U on FILTER	TIME OF VOIDING	LAST VOIDING	VOL CM^3	µg U Per L	Lung Burden mg U
Oct 12	800-2000	12-12	11.8	1.11	7:10 AM	11:25 PM	28	5	
					7:45 PM	2:05 PM	344	8	
Oct 13	800-2000	13-12	8.7	0.66	6:05 AM	11:00 PM	308	5	< 6 mg E
					6:15 PM	1:30 PM	239	3	
Oct 16	2000-800	16-12	10.3	0.96	7:20 PM	5:10 PM	102	<2	
					(17) 7:20 AM	4:10 AM	280	<2	
Oct 17	2000-800	17-12	9.8	0.62	7:15 PM	3:55 PM	94	<2	
Oct 18	2000-800	18-12	3.0	0.25	6:30 PM	3:20 PM	278	<2	
					(19) 7:40 AM	4:30 AM	391	<2	
Oct 21	800-2000	21-12	9.6	1.40	7:20 AM	9:45 PM	178	5	<6 mg B
					7:40 PM	2:15 PM	302	6	

TABLE 5

SUBJECT: 13

DATE	SHIFT	SAMPLE NO.	PUMP TIME	µg U on FILTER	TIME OF VOIDING	LAST VOIDING	VOL CM^3	µg U Per L	Lung Burden mg U
Sept 18	2000-800	18-13	10.3	0.91	11:25 PM	-	128	2	
					8:18 AM	5:57 AM	47	<2	
Sept 19	2000-800	19-13	6.8	0.51	6:15 PM	4:19 PM	120	<2	
					8:46 AM	11:14 PM	148	<2	
Sept 20	2000-800	20-13	0	-	6:44 PM	5:24 PM	78	<2	
			Pump Malfunction		6:54 AM	5:30 AM	134	5	
Sept 23	800-2000	23-13	9.3 (1.75 L/ Min)	0.60	6:18 AM	4:40 AM	83	<2	
					7:15 PM	6:45 PM	195	<2	
Sept 24	800-2000	24-13	10.0 (1.7 L/ Min)	1.82	6:22 AM	4:30 AM	113	2	
					7:15 PM	6:00 PM	124	<2	
Sept 28	2000-800	28-13	11.45	0.42	6:22 PM	5:15 PM	108	<2	< 6 mg B
					7:15 AM	5:50 AM	64	2	
Sept 29	2000-800	29-13	1.93	0.17	6:45 PM	5:30 PM	93	3	
					7:10 AM	6:00 AM	71	<2	
Oct 2	800-2000	2-13	8.3	0.89	6:15 AM	4:45 AM	62	<2	
					7:14 PM	5:30 PM	72	<2	
Oct 3	800-2000	3-13	9.8		6:18 AM	12:00 PM	477	<2	
					6:10 PM	5:00 PM	81	<2	< 6 mg E

TABLE 6

SUBJECT: 13

DATE	SHIFT	SAMPLE NO.	PUMP TIME	µg U on FILTER	TIME OF VOIDING	LAST VOIDING	VOL CM^3	µg U Per L	Lung Burden mg U
Oct 4	800-2000	4-13	9.9	1.20	5:45 AM 7:00 PM	4:30 AM 4:30 PM	52 170	< 2 < 2	
Oct 7	2000-800	7-13	10.5	0.53 0.39	7:20 AM	6:00 AM	19	10	
Oct 8	2000-800	8.13	8.7	0.35	5:45 PM	3:30 PM	155	< 2	< 6 mg E
Oct 12	800-2000	12-13	10.9	4.47	6:18 AM 7:10 PM	1:45 AM 6:50 PM	156 58	< 2 < 2	
Oct 13	800-2000	13-13	10.2	1.73	6:13 AM 7:10 PM	3:45 AM 5:30 PM	113 171	< 2 < 2	
Oct 16	2000-800	16-13	0	-	6:20 AM	4:45 AM	63	5	
Oct 17	2000-800	17-13	0	Not - at Work	6:09 AM	10:00 PM	250	< 2	
Oct 18	2000-800	18-13	0	-					
Oct 21	800-2000	21-13	10.9	1.87					< 6 mg B

TABLE 7

SUBJECT: 14

DATE	SHIFT	SAMPLE NO.	PUMP TIME	µg U on FILTER	TIME OF VOIDING	LAST VOIDING	VOL CM^3	µg U Per L	Lung Burden mg U
Sept 18	2000-800	18-14	9.9	0.26					
					7:00 AM	3:45 AM	180	<2	
Sept 19	2000-800	19-14	10.4	0.26	6:12 PM	6:05 PM	165	2	
					6:02 AM	12:30 AM	155	3	
Sept 20	2000-800	20.14	10.0	0.37	7:50 PM	6:10 PM	113	<2	
Sept 23	800-2000	23-14	10.9	0.40	5:50 AM	7:30 PM	413	<2	
					5:33 PM	1:00 Pm	176	<2	6.0 mg E
Sept 24	800-2000	24-14	8.0	0.42					
Sept 28	2000-800	28-14	10.5	0.18	5:51 PM	1:51 PM	78	<2	
					6:55 AM	1:00 AM	291	<2	
Sept 29	2000-800	29-14	10.4	0.59	7:00 AM	4:30 AM	102	<2	
					5:19 PM	1:36 PM	175	<2	< 6 mg B
Oct 2	800-2000	2-14	9.8	0.46	5:40 AM	11:18 PM	256	<2	
					6:30 PM	1:11 PM	224	2	
Oct 3	800-2000	3-4	9.8	0.49	5:35 AM	6:30 PM	356	<2	
					7:16 Pm	4:53 Pm	121	4	
Oct 4	800-2000	4-14	8.5	0.51	6:22 AM	9:50 PM	309	<2	
Oct 7	2000-800	7-14	9.6	0.30	5:04 PM	3:30 PM	204	<2	
					7:30 AM	4:19 AM	86	<2	< 6 mg E
Oct 8	2000-800	8-14	9.0	0.24	5:30 PM	1:00 PM	160	<2	
					5:50 AM	10:15 PM	231	<2	

TABLE 8

SUBJECT: 14

DATE	SHIFT	SAMPLE NO.	PUMP TIME	µg U on FILTER	TIME OF VOIDING	LAST VOIDING	VOL CM^3	µg U Per L	Lung Burden mg U
Oct 12	800-2000	12-14	9.1	2.11					< 6 mg B
Oct 13	800-2000	13-14	6.3	0.42	6:40 PM	1:30 PM	194	3	
Oct 16	2000-800	16-14	6.0	1.41					
Oct 17	2000-800	17-14	12.5	0.27	6:19 PM 5:30 AM	3:30 PM 3:30 AM	86 129	<2 <2	
Oct 18	2000-800	18-14	9.4	0.31	5:06 PM	1:30 PM	150	<2	< 6 mg E
Oct 21	800-2000	21-14	10 .9	0.52	5:28 AM 7:20 PM	11:00 PM 3:00 PM	190 166	14 3	

TABLE 9

SUBJECT: 15

DATE	SHIFT	SAMPLE NO.	PUMP TIME	µg U on FILTER	TIME OF VOIDING	LAST VOIDING	VOL CM^3	µg U Per L	Lung Burden mg U
Sept 18	2000-800	18-15	9.6	1.01					
					8:43 AM	5:14 AM	237	4	
Sept 19	2000-800	19-15	9.7	1.00	4:29 PM	2:02 PM	522	<2	
					10:06 AM	5:47 AM	243	4	
Sept 20	2000-800	20-15	9.8	2.78	2:53 AM	10:06 AM	1312	<2	
Sept 23	800-2000	23-15	9.2	1.08	5:49 AM	11:02 PM	499	<2	
					7:32 PM	10:23 AM	573	2	
Sept 24	800-2000	24-15	8.3	2.26	5:51 AM	11:10 PM	635	<2	
					5:40 PM	2:30 PM	132	6	7.5 mg E
Sept 28	2000-800	28-15	11.4	0.83	7:14 PM	5:30 PM	289	<2	
					7:34 AM	11:45 PM	497	3	
					7:27 AM	5:10 AM	108	<2	
Sept 29	2000-800	29-15	10.9	0.56	?	4:10 PM	249	<2	
Oct 2	800-2000	2-15	10.4	1.16	5:49 AM	4:45 AM	115	<2	
					7:29 AM	4:30 PM	184	4	< 6 mg B
Oct 3	800-2000	3-15	10.4	0.63	5:45 AM	11:10 PM	670	<2	
					7:30 PM	4:50 PM	114	4	
Oct 4	800-2000	4-15	11.5	2.12	5:45 AM	11:10 PM	440	<2	
					6:35 PM	4:10 PM	347	5	

SUBJECT: 15

TABLE 10

DATE	SHIFT	SAMPLE NO.	PUMP TIME	µg U on FILTER	TIME OF VOIDING	LAST VOIDING	VOL CM^3	µg U Per L	Lung Burden mg U
Oct 7	2000-800	8-15	10.2	0.66	5:48 PM	4:10 PM	319	<2	< 6 mg E
					6:12 AM	4:10 AM	205	8	
Oct 8	2000-800	8-15	10.o	0.93	5:57 PM	3:45 PM	300	<2	
					7:35 AM	4:10 AM	120	<2	
Oct 12	800-2000	12-15	11.2	1.16	5:48 AM	11:10 PM	625	<2	
					7:35 PM	4:10 PM	166	2	
Oct 13	800-2000	13-15	9.7	0.79	5:44 AM	11:05 PM	574	<2	< 6 mg B
					7:30 PM	4:30 PM	131	<2	
Oct 16	2000-800	16-15	10.4	6.73	6:05 PM	4:15 PM	256	<2	
					7:33 AM	4:30 AM	590	13	
Oct 17	2000-800	17-15	8.5	0.70	7:15 PM	4:20 PM	446	<2	
					7:29 AM	6:30 AM	36	2	
Oct 18	2000-800	18-15	8.7	0.81	5:42 PM	3:00 PM	327	<2	
					7:40 AM	3:50 AM	431	3	
Oct 21	800-2000	21-15	8.8	0.60	7:13 AM	5:30 AM	286	<2	< 6 mg E

TABLE 11

SUBJECT: 16

DATE	SHIFT	SAMPLE NO.	PUMP TIME	µg U on FILTER	TIME OF VOIDING	LAST VOIDING	VOL CM^3	µg U Per L	Lung Burden mg U
Sept 18	2000-800	18-16	10.4	0.30	7:15 AM	?	330	<2	
Sept 19	2000-800	19-16	11.1	0.37	3:30 PM	7:15 AM	355	<2	
					9:05 AM	3:05 AM	288	<2	
Sept 20	2000-800	20-16	10.0	0.36	10:45 PM	9:05 AM	265	<2	
					6:40 AM	11:05 PM	279	<2	
Sept 23	800-2000	23-16	8.9	0.49	6:08 AM	9:15 PM	284	<2	
					7:25 PM	1:25 PM	237	<2	
Sept 24	800-2000	24-16	11.0	1.21	6:20 AM	10:40 PM	177	3	
					7:25 PM	12:50 PM	284	2	
Sept 28	2000-800	28-16	10.1	0.22	5:10 PM	2:00 PM	424	<2	
					6:15 AM	2:30 AM	137	<2	< 6 mg E
Sept 29	2000-800	29-16	11.3	0.85	6:00 PM	9:20 AM	352	<2	
					7:30 AM	1:00 AM	224	<2	
Oct 2	800-2000	2-16	8.0	0.40	6:15 AM	10:30 PM	281	<2	
					7:25 PM	2:30 PM	215	2	
Oct 3	800-2000	3-16	9.7	0.80	6:30 AM	1:30 AM	169	<2	
					7:30 PM	2:00 PM	321	<2	< 6 mg B
Oct 4	800-2000	4-16	11.5	0.50	6:25 AM	10:30 PM	210	<2	
					7:30 PM	12:30 PM	420	<2	
Oct 7	2000-800	7-16	11.4	0.94	7:30 PM	4:30 PM	202	<2	
					7:35 AM	1:10 AM	359	2	

TABLE 12

SUBJECT: 16

DATE	SHIFT	SAMPLE NO.	PUMP TIME	µg U on FILTER	TIME OF VOIDING	LAST VOIDING	VOL CM^3	µg U Per L	Lung Burden mg U
Oct 8	2000-800	8-16	8.2	0.37	7:20 PM 6:25 AM	3:15 PM 12:30 AM	228 200	<2 5	< 6 mg E
Oct 12	800-2000	12-16	10.8	1.74	6:20 AM 7:20 PM	10:50 PM 2:30 PM	193 155	<2 4	
Oct 13	800-2000	13-16	8.8	0.50	6:20 AM 7:40 PM	11:45 PM 2:45 PM	172 169	3 <2	
Oct 16	800-2000	16-16	10.0	0.34					< 6 mg E
Oct 17	2000-800	17-16	7.7	0.33	7:20 PM 7:30 AM	5:00 PM 10:30 PM	100 258	<2 <2	
Oct 18	2000-800	18-16	10.4	0.25	6:40 PM 7:30 AM	3:55 PM 1:00 AM	115 205	<2 <2	< 6 mg B
Oct 21	800-2000	21-16	-	-	5:50 PM	1:45 PM	226	<2	

TABLE 13

SUBJECT: 21

DATE	SHIFT	SAMPLE NO.	PUMP TIME	µg U on FILTER	TIME OF VOIDING	LAST VOIDING	VOL CM^3	µg U Per L	Lung Burden mg U
Sept 22	730-1930	21-22	?	2.4					
					6:15 PM	-	174	22	
Sept 23	730-1930	21-23	15.5	3.3	5:55 AM	9:10 PM	579	7	
					7:20 AM	3:11 PM	233	11	
Sept 27	1930-0730	21-27		7.0	3:15 PM	8:10 AM	290	3	< 6 mg B
					7:30 AM	4:18 AM	218	11	
Sept 28	1930-0730	21-28		6.7	7:30 AM	11:55 PM	415	22	
Oct 1	730-1930	21-1		3.0	6:05 AM	-	446	<2	
					9:54 PM	5:30 PM	670	6	
Oct 2	730-1930	21-2		3.0	6:10 AM	10:35 PM	319	9	
					10:17 PM	3:00 PM	417	12	
Oct 3	730-1930	21-3		2.5	6:13 AM	11:59 PM	680	<2	
Oct 6	1930-0730	21-6		?	3:45 PM	12:15 PM	393	<2	
					6:15 AM	3:10 AM	285	7	
Oct 7	1930-0730	21-7		?					11.6 mg E
Oct 11	0730-1930	21-11		2.2	6:10 AM	11:00 PM	368	<2	
					7:20 PM	3:15 PM	406	9	
Oct 12	0730-1930	21-12	6.5	0.6	6:05 AM	11:00 PM	525	4	18 mg E
					7:24 PM	2:20 PM	253	4	
Oct 15	1930-0730	21-15		2.9	4:13 PM	9:10 AM	86	<2	< 6 mg B
					7:15 AM	3:44 AM	420	3	
Oct 16	1930-0730	21-16		4.5	5:56 PM	8:10 AM	230	2	
					7:16 AM	3:56 AM	409	5	
Oct 17	1930-0730	21-17		1.8	5:38 PM	7:57 PM	245	<2	14 mg E
					7:20 AM	4:20 AM	347	2	
Oct 20	?								
Oct 21	?								

TABLE 14

SUBJECT: 22

DATE	SHIFT	SAMPLE NO.	PUMP TIME	µg U on FILTER	TIME OF VOIDING	LAST VOIDING	VOL CM^3	µg U Per L	Lung Burden mg U
Sept 20	715-315 AM PM	22-20	5.3	4.5	6:15 AM 5:00 PM	 2:00 PM	328 266	5 17	
Sept 21	715-315	22-21	7.1	5.7 or 6.6	6:10 AM 3:11 PM	7:41 PM 1:45 PM	370 249	11 6	
Sept 22	715-315	22-22	6.7	7.3	6:12 AM 5:50 PM	11:25 PM 12:43 PM	582 258	4 13	
Sept 23	715-315	22-23	7.3	6.9	6:15 AM 3:00 PM	10:35 PM 12:20 PM	330 330	9 6	6.2 mg E
Sept 24	715-315	22-24	7.4	?	6:15 AM	10:52 PM	418	5	
Sept 27	315-1115 PM PM	22-27	6.2	15.6					
Sept 28	315-1115	22-28	No sample (BAT)		7:30 AM 11:15 PM	12:30 AM 8:45 PM	519 149	7 7	
Sept 29	315-1115	22-29	5.0	2.4	7:30 AM 11:25 PM	11:50 PM 9:30 PM	304 274	14 10	< 6 mg B
Sept 30	315-1115	22-30	7.8	1.6	7:30 AM 11:15 PM	12:30 AM 10:10 }PM 8:15 }	339 236	14 9	
Oct 1	315-1115	22-1	6.3	2.7	7:35 AM 11:15 PM	11:15 PM 9:15 PM	506 176	6 8	
Oct 4	715-315 AM PM	22-4	5.3	5.6	5:30 AM 3:15 PM	11:00 AM 2:00 PM	301 106	4 11	
Oct 5	715-315	22-5	?	4.0	5:30 AM 3:15 PM	10:45 PM 12:45 PM	423 245	5 4	
Oct 6	715-315	22-6	6.5	3.9	5:30 AM 3:15 PM	11:00 PM 1:00 PM	349 379	5 4	

TABLE 15

SUBJECT: 22

DATE	SHIFT	SAMPLE NO.	PUMP TIME	µg U on FILTER	TIME OF VOIDING	LAST VOIDING	VOL CM^3	µg U Per L	Lung Burden mg U
Oct 7	715-315	22-7	6.8	4.4	5:30 AM	11:00 PM	461	4	< 6 mg E
					3:15 PM	1:30 PM	211	3	
Oct 8	715-315	22-8	10.6	6.8	5:30 AM	11:15 PM	329	23	
					3:15 PM	2:15 PM	38	30	
Oct 11	315-1115 PM PM	22-11	6.3	2.8	5:30 AM	11:10 PM	176	11	
					11:15 PM	9:00 PM	142	9	
Oct 12	315-1115	22-12	6.4 **	2.8 **	7:30 AM	00:15 AM	346	9	
					11:15 PM	8:30 PM	216	8	
Oct 13	315-1115	22-13	6.1	3.2	10:20 AM	12:30 PM	606	5	
					11:10 PM	9:23 PM	168	6	
Oct 14	315-1115	22-14	7.7	1.6	5:30 AM	12:40 AM	415	6	
					11:10 PM	9:30 PM	223	4	
Oct 15	315-1115	22-15	7.7	3.7	7:30 AM	12:15 AM	495	4	< 6 mg B
					11:10 PM	8:40 PM	215	8	
Oct 18	715-315 AM PM	22-18	7.2	10.1	6:30 AM	11:30 PM	196	4	
					3:15 PM	1:45 PM	202	7	
Oct 19	715-315	22-19	7.1	6.3	6:30 AM	11:05 PM	370	5	
					3:10 PM	12:40 PM	290	6	
Oct 20	715-315	22-20	7.9	127.	6:30 AM	11:00 PM	497	6	
					3:10 PM	1:00 PM	266	100	
Oct 21	715-315	22-21	5.7	63.	5:45 AM	11:20 PM	301	8	< 6 mg E

** U 238 Spill

TABLE 16

SUBJECT: 23

DATE	SHIFT	SAMPLE NO.	PUMP TIME	µg U on FILTER	TIME OF VOIDING	LAST VOIDING	VOL CM^3	µg U Per L	Lung Burden mg U
Sept 20	0800-1630	23-20	6.8	0.64	8:45 PM	3:00 PM	266	<2	
Sept 21		23-21	7.9	0.36	6:15 AM	12:55 AM	233	<2	
					5:55 PM	2:45 PM	376	<2	
Sept 22		23-22	4.4	0.66	6:05 AM	11:05 PM	569	<2	
					6:10 PM	4:20 PM	144	<2	
Sept 23		23-23	7.8	0.47	7:45 AM	4:10 PM	212	<2	
					4:25 PM	12:30 PM	306	<2	
Sept 24		23-24	5.3	0.26	6:10 AM	10:50 PM	660	<2	
					4:25 PM	2:30 PM	157	<2	
Sept 27		23-27	6.2	0.40	6:10 AM	11:05 PM	251	<2	< 6 mg E
					3:15 PM	11:55 AM	312	<2	
Sept 28		23-28	7.6	0.58	6:00 AM	10:50 PM	485	<2	
					4:30 PM	2:50 PM	161	<2	
Sept 29		23-29	7.1	0.21	6:10 AM	11:05 PM	505	<2	
					4:30 PM	2:30 PM	201	<2	
Sept 30		23-20	7.3	0.27	6:05 AM	10:40 PM	365	<2	
					4:25 PM	12:30 PM	393	<2	
Oct 1		23-1	6.8	0.75	10:30 AM	5:15 AM	295	<2	
					4:30 PM	1:30 PM	314	<2	
Oct 4		23-4	8.0	0.70	6:20 AM	10:30 PM	378	<2	
					4:20 PM	1:35 PM	207	<2	
Oct 5		23-5	6.7	0.49	6:10 AM	11:30 PM	373	<2	
					4:25 PM	1:30 PM	279	<2	
Oct 6		23-6	6.1	0.67	6:15 AM	12:00 PM	569	<2	< 6 mg B
					4:30 PM	2:15 PM	250	<2	

TABLE 17

SUBJECT: 23

DATE	SHIFT	SAMPLE NO.	PUMP TIME	µg U on FILTER	TIME OF VOIDING	LAST VOIDING	VOL CM^3	µg U Per L	Lung Burden mg U
Oct 8	0800-1630	23-7	4.6	0.51	6:15 AM	11:00 PM	370	<2	
					4:20 PM	12:25 PM	430	3	
Oct 12		23-8	8.0	0.56	7:40 AM	5:10 AM	90	<2	
					4:30 PM	1:15 PM	311	<2	
Oct 13		23-13	8.0	0.74	6:00 AM	10:45 PM	579	<2	
Oct 14		23-14	3.7	0.38	7:40 AM	5:30 AM	57	<2	< 6 mg E
					3:00 PM	11:30 AM	248	<2	
Oct 15		23-15	7.0	1.89					
					4:30 PM	11:30 AM	270	4	

TABLE 18

SUBJECT: 24

DATE	SHIFT	SAMPLE NO.	PUMP TIME	µg U on FILTER	TIME OF VOIDING	LAST VOIDING	VOL CM^3	µg U Per L	Lung Burden mg U
Sept 20	315-1115 PM PM	24-20	5.4	7.6	2:15 PM 11:15 PM	10:20 AM 8:30 PM	246 176	6 11	
Sept 21	315-1115	24-21	3.0		2:15 PM 10:30 PM	12:30 PM 7:00 PM	187 167	4 10	
Sept 22	315-1115	24-22	3.0	8.3 or 3.0	1:30 PM (23) 1:15 AM	7:45 AM	377 427	7 5	
Sept 23	315-1115	24-23	2.8	5.5	12:30 PM	10:10 AM	214	5	< 6 mg B
Sept 24	315-1115	24-24	6.9	2.1 or 10.7	7:45 AM 11:15 PM	2:35 AM 8:45 PM	288 155	12 21	
Sept 27	715-315 AM PM	24-27	6.8		6:15 AM 3:07 PM	10:00 PM 12:45 PM	582 169	3 10	
Sept 28	715-315	24-28	6.0	3.0 or 1.7	7:00 AM 3:05 PM	11:30 PM 389 12:55 PM	179	9 9	12 mg E
Sept 29	715-315	24-29	6.6	7.0	6:40 AM 3:05 PM	11:30 PM 12:40 PM	528 222	3 13	
Sept 30	715-315	24-30	7.8	3.9	5:10 AM 3:05 PM	4:15 AM 11:10 AM	398 321	2 9	
Oct 1	715-315	24-1	6.9	6.3	6:20 AM 3:00 PM	11:10 PM 11:05 AM	437 285	6 10	
Oct 4	315-1115 PM PM	24-4	3.8	3.0	8:10 AM 11:10 PM	2:30 AM 8:05 PM	447 247	3 10	
Oct 5	315-1115	24-5	6.6	2.5	11:10 PM	10:35 PM	176	9	
Oct 6	315-1115	24-6	5.0	3.0	8:10 AM 11:10 PM	11:10 PM 9:25 PM	471 69	11 14	

TABLE 19

SUBJECT: 24

DATE	SHIFT	SAMPLE NO.	PUMP TIME	µg U on FILTER	TIME OF VOIDING	LAST VOIDING	VOL CM^3	µg U Per L	Lung Burden mg U
Oct 7	315-1115	24-7	6.0	3.8	8:35 AM	11:10 PM	591	17	
					11:10 PM	7:20 PM	35	3	
Oct 8	315-1115	24-8	3.2		8:10 AM	11:50 PM	440	24	9 mg B
					11:15 PM	6:30 PM	281	14	
Oct 11	715-315 AM PM	24-11	4.9		6:05 AM	11:10 PM	493	3	
					3:05 PM	11:20 AM	112	35	
Oct 12	715-315	24-12	7.0	6.0	6:05 AM	11:10 PM	476	7	
					3:10 PM	11:15 AM	186	15	
Oct 13	715-315	24-13	4.4	2.3	6:05 AM	11:05 PM	683	4	
					3:05 PM	11:30 AM	282	7	
Oct 14	715-315	24-14	7.3	4.0	6:05 AM	11:30 AM	692	< 2	
					3:05 PM	11:10 AM	305	8	
Oct 15	715-315	24-15	6.1	0.12	6:10 AM	11:05 PM	497	3	7.2 mg B
					3:10 PM	1:10 PM	133	11	
Oct 18	315-1115 PM PM	24-18	8.3	6.5	2:35 PM	11:00 AM	268	< 2	
					11:05 PM	8:30 PM	93	28	
Oct 19	315-1115	24-19	7.8	5.2	7:30 AM	1:45 AM	479	11	
					10:10 PM	6:30 PM	300	8	
Oct 20	315-1115	24-20	7.9	7.3	8:15 AM	1:30 AM	564	14	
					11:05 PM	6:30 PM	211	16	
Oct 21	315-1115	24-21	-		8:30 AM	11:05 PM	650	9	8.3 mg B
					11:05 PM	8:00 PM	203	10	

TABLE 20

SUBJECT: 25

DATE	SHIFT	SAMPLE NO.	PUMP TIME	µg U on FILTER	TIME OF VOIDING	LAST VOIDING	VOL CM^3	µg U Per L	Lung Burden mg U
Sept 20	730-430 AM PM	25-20	9.0	0.16 or 1.5	9:50 AM 4:00 PM	- 3:00 PM	80 80	3 4	
Sept 21		25-21	5.4	1.66	6:00 AM 5:50 PM	10:00 PM 3:50 PM	294 176	2 < 2	
Sept 22		25-22	8.1	1.90	6:00 AM 6:20 PM	8:35 PM 3:45 PM	301 130	2 4	
Sept 23		25-23	8.1	1.12	6:00 AM 2:30 PM	8:30 AM 12:30 PM	195 91	< 2 5	< 6 mg E
Sept 24		25-24	7.5		6:00 AM 3:45 PM	11:30 PM 1:00 PM	190 165	< 2 8	
Sept 27		25-27 D		1.56	7:00 AM 4:00 PM	6:00 AM 3:15 PM	25 26	< 2 3	
Sept 28		25-28 D			6:00 AM 9:15 PM	10:50 PM 3:45 PM	244 347	3 2	< 6 mg B
Sept 29		25-29 D	-		6:00 AM 5:30 PM	11:10 PM 3:50 PM	292 120	4 2	
Sept 30		25-30 D		2.1	6:00 AM 4:05 PM	10:30 PM 3:00 PM	280 31	< 2 7	
Oct 1		25-1 D		1.3	6:00 AM 4:00 PM	10:40 PM 2:00 PM	190 80	4 5	
Oct 4	730-930 AM PM	25-4 D		4.5	6:00 AM 11:10 PM	11:45 PM 6:00 PM	263 198	< 2 4	
Oct 5		25-5 D		1.98	6:00 AM 4:00 PM	11:30 PM 2:00 PM	204 93	2 5	
Oct 6		25-6 D		2.3	6:00 AM 4:00 PM	8:45 PM 1:50 PM	228 164	2 5	

D Dupont

TABLE 21

SUBJECT: 25

DATE	SHIFT	SAMPLE NO.	PUMP TIME	µg U on FILTER	TIME OF VOIDING	LAST VOIDING	VOL CM^3	µg U Per L	Lung Burden mg U
Oct 7	730-430 AM PM	$25\text{-}7_D$		0.84	6:00 AM 4:00 PM	10:20 PM 2:20 PM	122 101	< 2 3	<6 E
Oct 8		$25\text{-}8_D$		0.07	6:00 AM 4:00 PM	10:30 PM 2:00 PM	162 64	< 2 10	
Oct 12		$25\text{-}12_D$		2.3	6:00 AM 4:00 AM	11:00 PM 7:00 PM	187 37	< 2 17	
Oct 13		$25\text{-}13_D$		1.18	6:00 AM 4:00 PM	10:30 PM 2:00 PM	210 120	6 3	
Oct 14		$25\text{-}14_D$		1.05	6:00 AM 4:00 PM	10:30 PM 1.45 PM	261 242	< 2 < 2	
Oct 15		$25\text{-}15_D$		1.50	6:00 AM 4:10 PM	 3:15 PM	215 49	< 2 4	< 6 B
Oct 18	730-530 AM PM	25-18		2.2	6:00 AM 6:00 PM	2:00 AM 3:00 PM	170 153	< 2 8	
Oct 19	730-900 AM PM	25-19		1.41	6:00 AM 9:00 PM	10:00 PM 3:30 PM	245 262	3 4	
Oct 20		25-20		0.30	6:00 AM 4:00 PM	11:30 PM 1:30 PM	194 93	4 3	
Oct 21		25-21		0.86	6:00 AM 2:45 PM	11:30 PM 12:45 PM	184 162	< 2 2	<6 E

D - Dupont

TABLE 22

SUBJECT: 26

DATE	SHIFT	SAMPLE NO.	PUMP TIME	µg U on FILTER	TIME OF VOIDING	LAST VOIDING	VOL CM^3	µg U Per L	Lung Burden mg U
Sept 20	730-400 AM PM	26-20	8.0	0.21 0.99	10:33 AM 3:10 PM	- 10:33 AM	201 389	<2 <2	
Sept 21		26-21	7.5	1.60	6:20 AM 7:00 PM	11:00 PM 3:35 PM	443 291	2 <2	
Sept 22		26-22	9.0	1.60	6:20 AM 6:40 PM	2:00 AM	160 212	2 5	
Sept 23		26-23	13.0		6:25 AM 5:25 PM	1:43 AM	467 228	<2 <2	
Sept 24		26-24	7.5	1.84	6:20 AM		485	2	
Sept 27		$26\text{-}27_D$		0.86	6:10 PM	2:35 PM	286	<2	10.5 mg E
Sept 28		$26\text{-}28_D$		1.83	6:10 AM 3:14 PM	11:20 PM 10:10 AM	411 442	<2 <2	
Sept 29		$26\text{-}29_D$		0.25	6:00 AM 3:05 PM	11:10 PM 11:00 AM	402 281	<2 <2	
Sept 30		$26\text{-}30_D$		0.28	6:10 AM 2:57 PM	11:40 PM 11:00 AM	410 312	<2 3	
Oct 1		$26\text{-}1_D$		1.66	6:15 AM 3:00 PM	11:25 PM 11:00 AM	163 360	<2 2	
Oct 4		$26\text{-}4_D$		0.84 0.51	6:10 AM 3:05 PM	11:10 PM 12:10 AM	380 391	<2 <2	
Oct 5		$26\text{-}5_D$		0.59	6:10 AM 4:40 PM	11:55 PM 11:50 AM	179 333	<2 3	
Oct 6		$26\text{-}6_D$			8:00 AM	11:45 PM	251	<2	<6 mg B

TABLE 23

SUBJECT: 26

DATE	SHIFT	SAMPLE NO.	PUMP TIME	µg U on FILTER	TIME OF VOIDING	LAST VOIDING	VOL CM^3	µg U Per L	Lung Burden mg U
Oct 7	730-400 AM PM	26-7		0.05	6:00 AM	11:30 PM	514	<2	
					4:15 PM	12:20 PM	207	<2	
Oct 8		26-8		0.43	6:00 AM	11:50 PM	402	<2	
					6:00 PM	4:00 PM	165	<2	
Oct 12		26-12		0.76	6:00 AM	11:10 PM	477	<2	
					2:10 PM	1:00 PM	232	<2	
Oct 13		26-13		0.60	6:10 AM	11:00 PM	536	<2	
					3:00 PM	12:25 PM	276	<2	
Oct 14		26-14		0.65	6:15 AM	11:20 PM	492	<2	6.0 mg E
					2:30 PM	12:00 AM	354	<2	
Oct 15		26-15		1.43	6:05 AM	11:10 PM	492	<2	
Oct 18		26-18		1.32	6:05 AM	11:10 PM	198	<2	
					4:00 PM	12:05 PM	228	3	
Oct 19		26-19		0.84	6:05 AM	11:10 PM	406	3	
					4:00 PM	12:00 PM	440	6	
Oct 20		26-20		0.89	6:10 AM	11:10 PM	582	<2	<6 mg B
					4:00 PM	12:00 PM	380	3	
Oct 21		26-21		1.80	6:05 AM	11:15 PM	285	<2	
					4:00 PM	11:00 AM	242	6	

TABLE 24

SUMMARY OF LUNG BURDEN MEASUREMENTS

SUBJECT	NUMBER OF MEASUREMENTS ABOVE MDA* MEASURED AT BEGINNING OF SHIFT	AT END OF SHIFT	NUMBER NON-DETECTABLE MEASURED AT BEGINNING OF SHIFT	AT END OF SHIFT
11	0	0	2	3
12	0	0	1	2
13	0	0	2	2
14	0	1	2	2
15	0	1	2	2
16	0	0	2	3
21	0	3	2	0
22	0	1	2	2
23	0	0	1	2
24	3	1	1	0
25	0	0	2	2
26	0	2	2	0

* MDA = MINIMUM DETECTABLE AMOUNT

TABLE 25

SUBJECT DESCRIPTION

SUBJECT NO.	WORK AREA	EXPOSURE TO
11	DRUMS IN 'E' AREA	AMMONIUM DIURANATE
12	MANY AREAS INCLUDING CRUSHING AND GRINDING	"
13	SHIFT BOSS - VISITS ALL AREAS MOST OF TIME IN OFFICE	"
14	DRUMS IN 'J' AREA	"
15	VERY MOBILE	"
16	VERY MOBILE	"
21	PRECIPITATION	MAGNESIUM AND AMMONIUM DIURANATE
22	DRYING AND PACKING	MAGNESIUM AND AMMONIUM DIURANATE
23	PIPEFITTER, VERY MOBILE,	AMMONIUM DIURANATE
24	DRYING AND PACKING	MAGNESIUM AND AMMONIUM DIURANATE
25	MECHANIC, MOBILE	MAGNESIUM AND AMMONIUM DIURANATE
26	MECHANIC, MOBILE	MAGNESIUM AND AMMONIUM DIURANATE

TABLE 26

BACKGROUND RADIATION READINGS NEAR URANIUM MILLS

LOCATION	RADIATION FIELD UR/H
1. SMALL PARK	9.6
2. HOTEL A, PARKING LOT	14.
3. HOTEL B, PARKING LOT *	18.
4. HOTEL C, PARKING LOT	17.
5. HOTEL D, PARKING LOT	18.
(MONSERCO PARKING LOT MISSISSAUGA)	6.5)

* LOCATION OF MONSERCO MOBILE LUNG COUNTER

TABLE 27

TH234/U238 EQUILIBRIUM MEASUREMENTS

SAMPLE NO.	DESCRIPTION	EQUILIBRIUM RATIO
1.	FACILITY A PRECIP TANK SLUDGE 10-9-82	.60 (+/- 0.04)
2.	FACILITY B DRUM DRYER 10-11-82	0.63
3.	FACILITY A PRECIP TANK SPILLOVER 10-11-82	0.63
4.	FACILITY B DRYING AND PACKING PRODUCT 10-18-82	0.69
5.	FACILITY B DRYING AND PACKING PRODUCT 10-21-82	0.72
6.	FACILITY A J DRUM SLUDGE 10-8-82	N/D
7.	FACILITY A J DRUM SLUDGE 10-11-82	N/D
8.	FACILITY A J DRUM SLUDGE 10-17-82	N/D
9.	FACILITY A E DRUM SLUDGE 10-17-82	N/D
10.	FACILITY A J DRUM SLUDGE 10-21-82	N/D
11.	FACILITY A E DRUM SLUDGE 10-21-82	N/D

N/D NOT DETECTABLE BY GAMMA SPECTROSCOPY, TH232 AND DAUGHTER RADIATION PREDOMINATED THE GAMMA SPECTRA

TABLE 28

URANIUM IN URINE INTERLABORATORY COMPARISON

SAMPLE NO.	MONSERCO		RPB	SAMPLE NO.	MONSERCO		RPB
1	<2	<2	2	26	7	6	7
2	6	5	8	27	2	3	5
3	<2	<2	2	28	3	<2	3
4	<2	<2	2	29	10	9	8
5	<2	2	3	30	<2	<2	1
6	3	3	4	31	<2	<2	1
7	2	<2	2	32	4	2	4
8	4	3	4	33	<2	2	3
9	3	2	2	34	<2	<2	2
10	2	2	3	35	<2	<2	1
11	<2	<2	2	36	2	<2	1
12	<2	<2	3	37	4	4	4
13	3	3	4	38	17	23	15
14	6	4	5	39	<2	<2	1
15	<2	<2	2	40	<2	<2	2
16	<2	<2	2	41	4	15	2
17	7	6	6	42	3	<2	2
18	2	2	2	43	7	8	6
19	2	2	3	44	<2	<2	1
20	<2	<2	1	45	<2	<2	1
21	7	6	7	46	3	6	3
22	7	6	7	47	<2	<2	1
23	<2	<2	2	48	<2	<2	2
24	3	4	3	49	13	8	7
25	7	9	9	50	5	8	7
				51	3	<2	1
				52	6	2	3
				53	11	10	9
				54	<2	<2	2

UNITS OF MICROGRAMS URANIUM PER LITRE URINE

TABLE 29

STATIC AIR SAMPLES

LOCATION: FACILITY A NEW DRUMS 'J' PUMP 111 0.84 m^3/h

DATE	TIME ON	TIME OFF	AIR VOL. M^3	µg U ON FILTER	AIR CONCENTRATION µg U/m^3
9-18	10:00 PM	8:00 AM	8.4	3.8	0.45
9-19	8:00 PM	8:00 AM	10.1	6.0	0.60
9-20	8:00 PM	8:00 AM	10.1	11.2	1.11
9-23	8:00 AM	8:00 PM	10.1	12.8	1.27
9-24	8:00 AM	8:00 PM	10.1	11.7	1.16
9-28	8:00 PM	8:00 AM	10.1	1.5	0.15
10-3	8:00 AM	8:00 PM	10.1	16.3	1.61
10-4	8:oo AM	9:00 PM	10.9	12.5	1.14
10-7	8:00 PM	8:00 AM	10.1	6.8	0.68
10-8 *	8:00 PM	8:00 AM	10.1	8.4	0.84
10-12	8:00 AM	6:30 PM	8.8	7.0	0.79
10-13	8:00 AM	8:00 PM	10.1	15.1	1.50
10-17	8:00 PM	8:00 AM	10.1	20.0	2.0
10-21	8:00 AM	8:00 PM	10.1	17.6	1.74

* Position change from 1 to 2

TABLE 30

STATIC AIR SAMPLES

LOCATION: FACILITY A OLD DRUMS 'E' PUMP 112 0.60 m^3/h

DATE	TIME ON	TIME OFF	AIR VOL. M^3	µg U ON FILTER	µg U/m^3 AIR
9-18	9:30 PM	8:00 AM	6.3	10.5	1.67
9-19	8:00 PM	8:00 AM	7.2	16.5	2.3
9-20	8:00 PM	8:00 AM	7.2	15.3	2.1
9-23	8:00 AM	8:00 PM	7.2	16.2	2.3
9-24	8:00 AM	8:00 PM	7.2	33	4.6
9-28	8:00 PM	8:00 AM	7.2	1.91	0.27
9-29	8:00 PM	8:00 AM	7.2	12.4	1.72
9-30	8:00 PM	8:00 AM	7.2	8.8	1.22
10-2	8:00 AM	8:00 PM	7.2	14.3	1.99
10-3	8:00 AM	8:00 PM	7.2	8.0	1.11
10-4	8:00 AM	9:00 PM	7.8	9.4	1.21
10-7	8:00 PM	8:00 AM	7.2	10.1	1.40
10-8 *	8:00 PM	8:00 AM	7.2	9.8	1.36
10-12	9:30 AM	8:00 PM	6.3	101.	16.0
10-13	8:00 AM	8:00 PM	7.2	10.6	1.47
10-16	8:00 PM	8:00 AM	7.2	50.5	7.0
10-17	8:00 PM	8:00 AM	7.2	12.9	1.79
10-21	9:00 AM	8:00 PM	6.6	2.24	0.33

* Position change from 1 to 2

TABLE 31

STATIC AIR SAMPLES

LOCATION: FACILITY B PACKING PUMP 113 0.60 m^3/h

DATE	TIME ON	TIME OFF	AIR VOL. M^3	µg U ON FILTER	µg U/m^3 AIR
9-20	3:30 PM	11:00 PM	4.5	157	35
9-21	3:00 PM	11:00 PM	4.8	93	19.4
9-22	3:00 PM	11:00 PM	4.8	183	38
9-23	2:00 PM	11:00 PM	5.4	162	30
9-24	2:00 PM	11:00 PM	5.4	102	18.9
9-27	8:00 AM	2:30 PM	3.9	288	74
9-28	7:30 AM	2:30 PM	4.2	-	-
9-29	7:30 AM	2:30 PM	4.2	-	-
9-30	7:30 AM	2:30 PM	4.2	72	17.1
10-1	7:30 AM	2:30 PM	4.2	115	27
10-4	7:15 AM	3:15 PM	4.8	69	14.4
10-5	7:15 AM	3:15 PM	4.8	137	29
10-6	7:15 AM	3:15 PM	4.8	116	24
10-7	7:15 AM	3:15 PM	4.8	153	32
10-8	7:15 AM	3:15 PM	4.8	111	23
10-11	3:15 PM	11:15 PM	4.8	200	42
10-12	3:15 PM	11:15 PM	4.8	-	-
10-13	3:15 PM	11:15 PM	4.8	109	23
10-14	3:15 PM	11:15 PM	4.8	70	14.6
10-15	3:15 PM	11:15 PM	4.8	301	63
10-18	7:15 AM	3:15 PM	4.8	78	16.3
10-19	7:15 AM	3:15 PM	4.8	122	25
10-20	7:15 AM	3:15 PM	4.8	300	63
10-21	7:15 AM	3:15 PM	4.8	117	24

TABLE 32

STATIC AIR SAMPLES

LOCATION: FACILITY B DRYING PUMP 114 0.84 m^3/h

DATE	TIME ON	TIME OFF	AIR VOL. M^3	µg U ON FILTER	µg U/m^3 AIR
10-18	3:15 PM	11:15 PM	6.72	98	14.6
10-19	3:15 PM	11:15 PM	6.72	86	12.8
10-20	3:15 PM	11:15 PM	6.72	165	25
10-21	3:15 PM	11:15 PM	6.72	203	30

TABLE 33

STATIC AIR SAMPLES

LOCATION: FACILITY B PRECIPITATION PUMP 114 0.84 m^3/h

DATE	TIME ON	TIME OFF	AIR VOL. M^3	µg U ON FILTER	µg U/m^3 AIR
9-22	12:00 AM	6:00 PM	5.0	33	6.6
9-23	12:00 PM	6:00 PM	5.0	44	8.8
9-27	8:30 AM	7:30 PM	9.2	-	
9-28	7:30 AM	7:30 PM	10.1	99	9.9
10-1	7:30 AM	7:30 PM	10.1	62	6.2
10-2	7:30 AM	7:30 PM	10.1	289	29
10-3	7:30 AM	7:30 PM	10.1	76	7.6
10-6	7:30 AM		10.1	168	16.8
10-7			10.1	167	16.7
10-11	7:30 AM	7:30 PM	10.1	105	10.5
10-12	7:30 AM	7:30 PM	10.1	38	3.8
10-15	7:30 PM	7:30 AM	10.1	69	6.9
10-16	7:30 PM	7:30 AM	10.1	15	1.5
10-17	7:30 PM	7:30 AM	10.1	29	2.9

TABLE 34

SUMMARY OF PERSONAL AIR SAMPLE AND URINALYSIS MEASUREMENTS

SUBJECT	PERSONAL AIR MEASUREMENTS UG U INHALED/12 HOURS AVERAGE	STANDARD DEV.	END OF SHIFT URINALYSIS UG U / LITRE URINE AVERAGE	STANDARD DEV.
11	8.7	3.1	4.8	2.8
12	12.9	12.0	3.6	2.1
13	11.4	6.3	2.9	3.0
14	4.8	1.9	-	-
15	17.3	17.	4.1	3.1
16	7.0	4.6	-	-
21	34.	18.	8.4	5.7
22	153.	310.	13.1	21.
23	-	-	-	-
24	63.	35.	12.3	7.5
25	16.2	9.7	4.8	3.5
26	-	-	-	-

TABLE 35

SUMMARY OF URANIUM UPTAKES INDICATED BY URINALYSIS AND PERSONAL AIR SAMPLING

SUBJECT	DATE OF OCCURANCE	INTAKE >1 STANDARD DEVIATION ABOVE AVERAGE INDICATED BY PERSONAL AIR SAMPLING FALSE NEG.	FALSE POS.	BY END OF SHIFT URINALYSIS FALSE NEG.	FALSE POS.
11	SEPT 24		AGREEMENT		
	SEPT 29	X			X
	OCT 18		FP		
	OCT 21	X			X
12	SEPT 24		AGREEMENT		
	SEPT 28		X	X	
	OCT 12	X			X
	OCT 21	X			X
13	SEPT 24		X	X	
	OCT 7	X			X
	OCT 13		X	X	
14		URINE CONCENTRATION GENERALLY BELOW MDA			
15	OCT 7	X			X
	OCT 16		AGREEMENT		
16		URINE CONCENTRATION GENERALLY BELOW MDA			
21	SEPT 27		X	X	
	SEPT 28		AGREEMENT		
22	OCT 20		AGREEMENT		
23		URINE CONCENTRATION GENERALLY BELOW MDA			
24	SEPT 20		X	X	
	SEPT 23		FP		
	OCT 18	X			X
25	OCT 4		X	X	
	OCT 8	X			X
	OCT 12	X			X
26		URINE CONCENTRATION GENERALLY BELOW MDA			

APPENDIX 1

RESULTS ON 72 HOUR CONTINUOUS URINE SAMPLING TEST

MONSERCO LIMITED

6620 KITIMAT ROAD
MISSISSAUGA, ONTARIO
L5N 2B8
TEL. 416-821-1033

URANIUM ANALYSIS IN URINE
SERVICE REPORT

REFERENCE: U-347

COMPANY NAME: PROJECT 271
AECB Mill Study

REPORT DATE: SEPT 28/82

SAMPLES RECEIVED: SEPT. 22/82 105 SPECIMENS

RESULTS TELEPHONED: NO

ANALYSIS PROCEDURE: M12 REV 0

MONSERCO CODE	COMPANY CODE	SAMPLE DATE D/M/Y	NATURAL URANIUM IN URINE MICROGRAM/LITRE
3	11 18/9 8.45 PM 202		3
4	11 19/9 3.50 AM 192		4.
5	11 19/9 7.43 AM 164		6
6	11 19/9 3.05 PM 493		<2
7	11 19/9 7.20 PM 154		2.
8	11 19/9 10.05 PM 172		3.
9	11 20/9 7.47 AM 195		3.
10	11 20/9 11.00 AM 632		<2
11	11 20/9 1.50 PM 351		<2
12	11 20/9 2.20 PM 494		<2
13	11 20/9 7.50 PM 167		2.
14	11 21/9 5.15 AM 209		5.
15	11 21/9 7.50 AM 123		4.
16	12 18/9 3.00 AM 303		2.
17	12 18/9 640 AM 450		2.
18	12 18/9 11.55 PM 449		2.
19	12 19/9 1.05 AM 165		<2
20	12 19/9 7.30 AM 357		2.
21	12 19/9 8.08 AM 460		<2
22	12 19/9 1.50 PM 558		<2

MONSERCO CODE	COMPANY CODE	SAMPLE DATE D/M/Y	NATURAL URANIUM IN URINE MICROGRAM/LITRE
23	12 19/9 7.25 PM 210		<2
24	12 19/9 10.10 PM 245		<2
25	12 20/9 1.30 AM 192		3
26	12 20/9 6.30 AM 239		4
27	12 20/9 12.25 PM 421		3.
28	12 20/9 5.00 PM 374		<2
29	12 20/9 6.30 PM 172		<2
30	12 20/9 9.50 PM 303		3.
31	13 18/9 2.28 AM 121		<2
32	13 18/9 4.16 AM 156		<2
33	13 18/9 7.09 AM 96		3.
34	13 18/9 11.25 PM 128		2.
35	13 19/9 12.54 AM 234		6.
36	13 19/9 3.51 AM 294		<2
37	13 19/9 5.57 AM 237		<2
38	13 19/9 8.19 AM 47		<2
39	13 19/9 10.20 AM 503		<2
40	13 19/9 12.45 PM 261		<2
41	13 19/9 4.19 PM 211		<2
42	13 19/9 6.15 PM 120		<2
43	13 19/9 9.36 PM 112		3
44	13 19/9 11.14 PM 101		<2
45	13 20/9 8.46 AM 148		<2
46	13 20/9 5.24 PM 199		2.
47	13 20/9 6.44 PM 78		<2
48	13 20/9 8.35 PM 103		<2
49	13 20/9 10.37 PM 142		2.
50	13 21/9 12.43 AM 466		3.
51	13 21/9 5.30 AM 265		4.
52	13 21/9 6.54 AM 134		5.
55	14 18/9 3.45 AM 277		<2
56	14 18/9 7.00 AM 180		<2
57	14 18/9 10.00 PM 100		<2
58	14 19/9 1.20 AM 170		3
59	14 19/9 1.40 PM 233		2

MONSERCO CODE	COMPANY CODE	SAMPLE DATE D/M/Y	NATURAL URANIUM IN URINE MICROGRAM/LITRE
60	14 19/9 6.05 PM 165		<2
61	14 19/9 6.12 PM 165		2.
62	14 19/9 9.07 PM 132		2.
63	14 19/9 9.40 PM 15		3.
64	14 20/9 12.30 AM 156		<2
65	14 20/9 6.02 AM 155		3.
66	14 20/9 1.30 PM 328		2.
67	14 20/9 6.10 PM 132		<2
68	14 20/9 7.50 PM 113		<2
69	14 20/9 9.20 PM 105		<2
70	15 19/9 12.32 AM 262		3
71	15 19/9 5.14 AM 330		4.
72	15 19/9 8.43 AM 237		4.
73	15 19/9 2.02 PM 612		<2
74	15 19/9 2.02 PM 627		3
75	15 19/9 4.29 PM 522		<2
76	15 19/9 10.30 PM 564		2.
77	15 20/9 1.32 AM 412		3.
78	15 20/9 5.40 AM 491		4.
79	15 20/9 5.47 AM 344		5.
80	15 20/9 10.06 AM 243		4.
81	15 20/9 2.53 PM 690		<2
82	15 20/9 2.53 PM 622		<2
83	15 20/9 9.36 PM 124		3.
84	16 19/9 7.15 AM 330		<2
85	16 19/9 3.30 PM 355		<2
86	16 19/9 9.00 PM 307		<2
87	16 20/9 5.15 PM 281		<2
88	16 20/9 3.05 AM 262		<2
89	16 20/9 9.05 AM 288		<2
90	16 20/9 10.45 PM 265		<2
91	16 19/9 11.05 PM 245		<2
92	16 21/9 6.40 AM 279		<2
93	22 20/9 9.35 PM 188		9.
94	25 20/9 9.50 AM 80		3.

REFERENCE: U-347

MONSERCO CODE	COMPANY CODE	SAMPLE DATE D/M/Y	NATURAL URANIUM IN URINE MICROGRAM/LITRE
95	25 20/9 12.50 PM 152		0.
96	25 20/9 4.00 PM 80		4.
97	25 20/9 3.00 PM 122		<2
98	26 20/9 10.33 AM 201		<2
99	26 20/9 3.10 PM 389		<2
100	11 20/9 12.05 AM 243		0.
103	DUP MONSERCO 6 RPB 4		<2
104	DUP MONSERCO 17 RPB 5		<2
105	DUP MONSERCO 27 RPB 6		3
106	DUP MONSERCO 39 RPB 7		0
107	DUP MONSERCO 50 RPB 8		4.
108	DUP MONSERCO 66 RPB 9		0.
109	DUP MONSERCO 76 RPB 10		2
110	DUP MONSERCO 86 RPB 11		<2
111	DUP MONSERCO 99 RPB 12		<2

* SPECIMEN LESS THAN 40 ML REQUIRED FOR PROCEDURE M12, ACCURACY REDUCED

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URANIUM ANALYSIS IN URINE
SERVICE REPORT

REFERENCE: U-348

COMPANY NAME: Project 271
AECB Mill Study

REPORT DATE: SEPT. 28/82

SAMPLES RECEIVED: SEPT. 24/82 102 SPECIMENS

RESULTS TELEPHONED: NO

ANALYSIS PROCEDURE: M12 REV 0

MONSERCO CODE	COMPANY CODE	SAMPLE DATE D/M/Y	NATURAL URANIUM IN URINE MICROGRAM/LITRE
131	21 22/9 6.15 PM 174		22.
132	22 20/9 6.15 AM 328		5.
133	22 20/9 8.07 AM 293		2.
134	22 20/9 10.40 AM 361		7.
135	22 20/9 1.15 PM 410		7.
136	22 20/9 2.00 PM 288		3.
137	22 20/9 5.00 PM 266		17.
138	22 20/9 6.22 PM 309		7
139	22 20/9 7.41 PM 328		6.
140	22 21/9 6.10 AM 370		11.
141	22 21/9 9.36 AM 585		3.
142	22 21/9 11.17 AM 344		3
143	22 21/9 12.22 PM 230		4.
144	22 21/9 1.05 PM 268		2.
145	22 21/9 1.45 PM 433		3.
146	22 21/9 3.11 PM 249		6.
147	22 21/9 6.10 PM 286		8.
148	22 21/9 7.12 PM 302		<2
149	22 21/9 7.45 PM 308		<2
150	22 21/9 8.30 PM 386		<2

NONSERCO CODE	COMPANY CODE	SAMPLE DATE D/M/Y	NATURAL URANIUM IN URINE MICROGRAM/LITRE
151	22 21/9 11.25 PM 234		6.
152	22 22/9 6.12 AM 582		4.
153	22 22/9 8.50 AM 250		6.
154	22 22/9 9.30 AM 342		<2
155	22 22/9 11.51 AM 251		9.
156	22 22/9 12.43 PM 550		<2
157	22 22/9 5.50 PM 258		10.
158	22 22/9 10.35 PM 300		5.
159	22 22/9 6.15 AM 330		9.
160	22 23/9 10.45 AM 604		6.
162	23 20/9 3.00 PM 235		<2
164	23 20/9 8.45 PM 266		<2
165	23 21/9 0.55 AM 300		<2
166	23 21/9 6.15 AM 233		<2
167	23 21/9 10.25 AM 255		<2
168	23 21/9 2.45 PM 241		<2
169	23 21/9 5.55 PM 376		<2
170	23 21/9 8.45 PM 370		<2
171	23 21/9 11.05 PM 188		2.
172	23 22/9 6.05 AM 569		<2
173	23 22/9 7:45 am 98		<2
174	23 22/9 9.15 AM 304		<2
175	23 22/9 11.50 AM 264		<2
176	23 22/9 2.25 PM 234		3.
177	23 22/9 4.20 PM 257		2.
178	23 22/9 6.10 PM 144		<2
179	23 22/9 8.45 PM 248		<2
180	23 23/9 4.10 AM 508		<2
181	23 23/9 7.45 AM 212		<2
182	24 20/9 10.20 AM 254		4.
183	24 20/9 2.15 PM 246		6.
184	24 20/9 5.10 PM 170		5.
185	24 20/9 8.30 PM 208		9.
186	24 20/9 11.15 PM 176		11.
187	24 21/9 7.40 AM 625		11.

MONSERCO CODE	COMPANY CODE	SAMPLE DATE D/M/Y	NATURAL URANIUM IN URINE MICROGRAM/LITRE
188	24 21/9 12.30 PM 403		5.
189	24 21/9 2.15 PM 187		4
190	24 21/9 5.10 PM 282		6.
191	24 21/9 7.00 PM 229		14
192	24 21/9 10.30 PM 167		10.
193	24 22/9 7.45 AM 645		6.
194	24 22/9 1.30 PM 377		7.
195	24 22/9 6.25 PM 301		10.
196	25 20/9 8.00 PM 170		4.
197	25 20/9 10,00 PM 106		2.
198	25 21/9 6.00 AM 294		2.
199	25 21/9 7.10 AM 31		<2
200	25 21/9 11.00 AM 63		3.
201	25 21/9 12.40 PM 84		7.
202	25 21/9 1.53 PM 140		3.
203	25 21/9 3.50 PM 219		2.
204	25 21/9 5.50 PM 176		<2
205	25 21/9 8.35 PM 168		2.
206	25 21/9 8,35 PM 124		<2
207	25 22/9 6,00 AM 301		2.
208	25 22/9 8.15 AM 169		<2
209	25 22/9 10,00 AM 129		<2
210	25 22/9 12.25 PM 136		4.
211	25 22/9 2.50 PM 102		5.
212	25 22/9 3.45 PM 25		8.
215	26 20/9 7.15 PM 450		<2
216	26 20/9 8.43 PM 154		<2
217	26 20/9 10.00 PM 397		<2
218	26 20/9 11.00 PM 387		<2
219	26 21/9 6.20 AM 443		2.
220	26 21/9 9 53 AM 244		3.
221	26 21/9 12.33 PM 284		3
222	26 21/9 3.35 PM 210		3
223	26 21/9 7.00 PM 291		<2
224	26 21/9 9.30 PM 380		<2

MONSERCO CODE	COMPANY CODE	SAMPLE DATE D/M/Y	NATURAL URANIUM IN URINE MICROGRAM/LITRE
225	26 21/9 11.00 PM 220		15
226	26 22/9 2.00 AM 193		<2
227	26 22/9 6.20 AM 160		2
228	26 22/9 12.44 PM 350		2.
229	26 22/9 3.30 PM 230		5
230	DUP MONSERCO #141 RPD 13		3
231	DUP MONSERCO #152 RPD 14		6.
232	DUP MONSERCO #165 RPD 15		<2
233	DUP MONSERCO #180 RPD 16		<2
234	DUP MONSERCO #193 RPD 17		7
235	DUP MONSERCO #207 RPD 18		2.
236	DUP MONSERCO #219 RPD 19		2.

* SPECIMEN LESS THAN 40 ML REQUIRED FOR PROCEDURE M12, ACCURACY REDUCED

CERTIFIED BY: Morley Davies

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URANIUM ANALYSIS IN URINE
SERVICE REPORT

REFERENCE: U-350

COMPANY NAME: PROJECT 271
AECB MILL STUDY

REPORT DATE: OCT. 5/82

SAMPLES RECEIVED: SEPT 29/82 50 SPECIMENS

RESULTS TELEPHONED: NO

ANALYSIS PROCEDURE: M12 REV 0

MONSERCO CODE	COMPANY CODE	LAST VOIDING TIME/DATE	NATURAL URANIUM IN URINE MICROGRAM/LITRE
3	11 22/9 530 AM 605	21/9 1130 PM	<2
4	11 23/9 630 AM 367	22/9 1130 PM	<2
5	11 24/9 630 AM 461	23/9 1130 PM	3.
6	11 24/9 645 PM 136	24/9 400 PM	8.
7	12 23/9 630 AM 447	22/9 1130 PM	<2
8	12 23/9 730 PM 118	23/9 500 PM	3.
9	12 24/9 635 AM 226	23/9 1030 PM	2.
10	12 24/9 755 PM 344	24/9 300 PM	7.
11	13 23/9 618 AM 83	23/9 440 AM	<2
12	13 23/9 715 PM 195	23/9 645 PM	<2
13	13 24/9 622 AM 113	24/9 430 AM	2.
14	13 24/9 715 PM 124	24/9 600 PM	<2
15	14 23/9 550 AM 413	22/9 730 PM	<2
16	14 23/9 533 PM 176	22/9 100 PM	<2
17	15 23/9 549 AM 499	22/9 1102 PM	<2
18	15 23/9 732 PM 573	23/9 1023 AM	2.
19	15 24/9 551 AM 633	23/9 1110 PM	<2
20	15 24/9 540 PM 132	24/9 230 PM	6.
21	16 23/9 608 AM 284	22/9 915 PM	<2
22	16 23/9 725 PM 237	23/9 125 PM	<2

MONSERCO CODE	COMPANY CODE	LAST VOIDING TIME/DATE	NATURAL URANIUM IN URINE MICROGRAM/LITRE
23	16 25/9 725 PM 284	24/9 1250 PM	2
24	21 23/9 555 AM 579	22/9 910 PM	7
25	21 23/9 720 PM 233	23/9 311 PM	11.
26	22 22/9 1210 PM 321		9
27	22 22/9 315 PM 64		19
28	22 22/9 705 PM 323		2
29	22 22/9 830 PM 327		3
30	23 23/9 425 PM 306	23/9 1230 PM	<2
31	24 22/9 145 AM 467		4.
32	24 22/9 910 AM 476		7.
33	24 22/9 840 PM 141		13.
34	25 22/9 620 PM 130		4
35	25 22/9 830 PM 121		<2
36	25 23/9 600 AM 195		<2
37	25 23/9 230 PM 91	23/9 1230 PM	5.
38	25 24/9 600 AM 190	23/9 1130 PM	<2
39	25 24/9 345 PM 165	24/9 100 PM	8.
40	26 22/9 640 PM 212		5
41	26 22/9 805 PM 517		<2
42	26 22/9 1000 PM 227		<2
43	26 22/9 1100 PM 266		<2
44	26 23/9 143 AM 272		<2
45	26 23/9 625 AM 467		<2
46	26 23/9 525 PM 228		<2
47	26 24/9 620 AM 485		2.
48	26 24/9 200 PM 525		<2
51	MONS DUP #15 RPB 20		<2
52	MONS DUP #24 RPB 21		6.
53	MONS DUP #32 RPB 22		6.
54	MONS DUP #45 RPB 23		<2

CERTIFIED BY: Morley Davis

MONSERCO LIMITED